

6,894,517.

**North America
Intellectual Property Corporation**

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Fax: (703) 308-6672

FROM: Winston Hsu, PATENT AGENT, REG. NO.: 41,526

SERIAL NO.: 10/065,432

ATTORNEY DOCKET NO.: NAUP0496USA

**SUBJECT: REQUEST FOR CERTIFICATE OF
CORRECTION**

TOTAL PAGES: 27 PAGES (INCLUDING COVER PAGE)

Winston Hsu JUL 15 2005

NAUP0496USA0_AS_1

JUL 20 2005

PTO/SB/97 (09-04)

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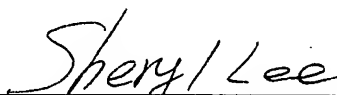
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Application Number: 10/065,432

(1) Transmittal Form	1 PAGE
(2) Fee Transmittal Form	1 PAGE
(3) Statement of request for COC	2 PAGES
(4) Attachments	21 PAGES

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**TRANSMITTAL
FORM**

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Total Number of Pages in This Submission

25

Application Number	10/065,432
Filing Date	10/17/2002
First Named Inventor	Ting-Kuo Kang
Art Unit	2829
Examiner Name	Evan Pert
Attorney Docket Number	NAUP0496USA

ENCLOSURES (Check all that apply)

<input checked="" type="checkbox"/> Fee Transmittal Form <input type="checkbox"/> Fee Attached <input type="checkbox"/> Amendment/Reply <input type="checkbox"/> After Final <input type="checkbox"/> Affidavits/declaration(s) <input type="checkbox"/> Extension of Time Request <input type="checkbox"/> Express Abandonment Request <input type="checkbox"/> Information Disclosure Statement <input type="checkbox"/> Certified Copy of Priority Document(s) <input type="checkbox"/> Reply to Missing Parts/ Incomplete Application <input type="checkbox"/> Reply to Missing Parts under 37 CFR 1.52 or 1.53	<input type="checkbox"/> Drawing(s) <input type="checkbox"/> Licensing-related Papers <input type="checkbox"/> Petition <input type="checkbox"/> Petition to Convert to a Provisional Application <input type="checkbox"/> Power of Attorney, Revocation Change of Correspondence Address <input type="checkbox"/> Terminal Disclaimer <input type="checkbox"/> Request for Refund <input type="checkbox"/> CD, Number of CD(s) _____ <input type="checkbox"/> Landscape Table on CD	<input type="checkbox"/> After Allowance Communication to TC <input type="checkbox"/> Appeal Communication to Board of Appeals and Interferences <input type="checkbox"/> Appeal Communication to TC (Appeal Notice, Brief, Reply Brief) <input type="checkbox"/> Proprietary Information <input type="checkbox"/> Status Letter <input checked="" type="checkbox"/> Other Enclosure(s) (please identify below): -Statement of request for COC -A copy of the front page of the Patent -A copy of the submission of RCE filed on 11/12/2004. -A copy of the notice of allowance.
Remarks _____		

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	North America Intellectual Property Corporation		
Signature	<i>Winston Hsu</i>		
Printed name	Winston Hsu		
Date	JUL 15 2005	Reg. No.	41,526

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Typed or printed name		Date	

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Effective on 12/08/2004.

Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

FEE TRANSMITTAL
For FY 2005☐ Applicant claims small entity status. See 37 CFR 1.27**TOTAL AMOUNT OF PAYMENT** (\$) 0.00**Complete If Known**

Application Number	10/065,432
Filing Date	10/17/2002
First Named Inventor	Ting-Kuo Kang
Examiner Name	Evan Pert
Art Unit	2829
Attorney Docket No.	NAUP0496USA

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): _____

☒ Deposit Account Deposit Account Number: 50-3105 Deposit Account Name: North America Intellectual Property Corp.

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☒ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, except for the filing fee

☒ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☒ Credit any overpayments

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FEE CALCULATION**1. BASIC FILING, SEARCH, AND EXAMINATION FEES**

Application Type	FILING FEES		SEARCH FEES		EXAMINATION FEES		Fees Paid (\$)
	Fee (\$)	Small Entity Fee (\$)	Fee (\$)	Small Entity Fee (\$)	Fee (\$)	Small Entity Fee (\$)	
Utility	300	150	500	250	200	100	
Design	200	100	100	50	130	65	
Plant	200	100	300	150	160	80	
Reissue	300	150	500	250	600	300	
Provisional	200	100	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	Fee (\$)	Small Entity Fee (\$)
Each claim over 20 or, for Reissues, each claim over 20 and more than in the original patent	50	25
Each independent claim over 3 or, for Reissues, each independent claim more than in the original patent	200	100
Multiple dependent claims	360	180

Total Claims	Extra Claims	Fee (\$)	Fee Paid (\$)	Multiple Dependent Claims	Fee (\$)	Fee Paid (\$)
- 20 or HP =	x	=				
HP = highest number of total claims paid for, if greater than 20						
Indep. Claims	Extra Claims	Fee (\$)	Fee Paid (\$)			
- 3 or HP =	x	=				
HP = highest number of independent claims paid for, if greater than 3						

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$250 (\$125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets	Extra Sheets	Number of each additional 50 or fraction thereof	Fee (\$)	Fee Paid (\$)
- 100 =	/ 50 =	(round up to a whole number) x	=	

4. OTHER FEE(S)

Non-English Specification, \$130 fee (no small entity discount)

Other: _____

Fees Paid (\$)**SUBMITTED BY**

Signature	<i>Winston Hsu</i>	Registration No. (Attorney/Agent)	41,526	Telephone	302-729-1562
Name (Print/Type)	Winston Hsu	Date	JUL 15 2005		

This collection of information is required by 37 CFR 1.136. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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JUL 20 2005

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent No.: 6,894,517 Issue Date: 05/17/2005
5 App. No.: 10/065,432 Filing Date: 10/17/2002
Inventors : Ting-Kuo Kang et al.
Examiner: Evan Pert Art Unit: 2829
Docket No.: NAUP0496USA

10 Title: METHOD OF MANUFACTURING A SEMICONDUCTOR DEVICE
HAVING AN OXIDE LAYER

To: Commissioner for Patents
P.O. BOX 1450
15 Alexandria, VA 22313-1450

Subject: Request for Certificate of Correction under 37 CFR 1.322

Dear Sir,

20

Upon reviewing the above-identified patent, patentee noted the title of the invention should be corrected. Applicant has requested to amend the invention title when submitting RCE of the above-identified patent on November 12, 2004. And the notice of allowance also indicates that the title was amended. According to both
25 of the reasons this mistake should be considered as an Office mistake of consequence. As the agent of record, I hereby request that a Certificate of Correction be issued under 37 CFR 1.322 to correct invention title from "Method for Monitoring Oxide Quality" to "Method Of Manufacturing A Semiconductor Device Having An Oxide Layer".

30

Attachments

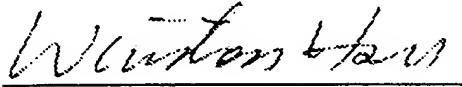
* A copy of the front page of the Patent

* A copy of the submission of RCE filed on 11/12/2004.

* A copy of the notice of allowance.

Respectfully submitted,

5



Date: JUL 15 2005

Winston Hsu, Patent Agent No. 41,526

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10 Facsimile: 806-498-6673

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Note: Please leave a message in my voice mail if you need to talk to me. (The time in D.C. is 12 hours behind the Taiwan time, i.e. 9 AM in D.C. = 9 PM in Taiwan.)

15



US006894517B2

(12) **United States Patent**
Kang et al.

(10) Patent No.: **US 6,894,517 B2**
(45) Date of Patent: **May 17, 2005**

(54) **METHOD FOR MONITORING OXIDE QUALITY**

(75) Inventors: **Ting-Kuo Kang, Kao-Hsiung Hsien**
(TW); **Yi-Fan Chen, Tai-Chung (TW);**
Chia-Jen Kao, Hsin-Chu (TW)

(73) Assignee: **United Microelectronics Corp.,**
Hsin-Chu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 135 days.

(21) Appl. No.: **10/065,432**

(22) Filed: **Oct. 17, 2002**

(65) **Prior Publication Data**

US 2004/0077110 A1 Apr. 22, 2004

(51) Int. Cl.⁷ **G01R 31/02**

(52) U.S. Cl. **324/765; 324/766**

(58) Field of Search **438/5-18; 324/765,**
324/557, 558, 71.1, 71.5, 766

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,583,641 B2 * 6/2003 Wang et al. 324/765

* cited by examiner

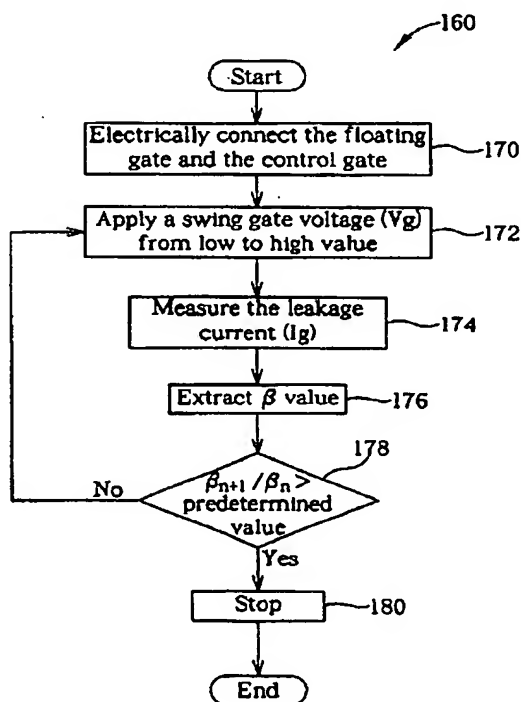
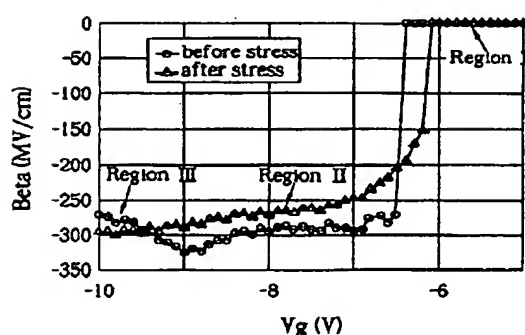
Primary Examiner—Evan Pert

(74) *Attorney, Agent, or Firm*—Winston Hsu

(57) **ABSTRACT**

The present invention utilizes to wafer acceptance testing equipment to fast monitor the quality of a tunnel oxide layer. First, a control gate and a floating gate in a memory cell are electrically connected. Then a plurality of swing time-dependent DC ramping voltages are applied and each corresponding gate leakage current is measured to calculate each corresponding β value. Finally a ratio of each β value is calculated and a β -gate voltage curve is plotted to actually simulate the device failure.

43 Claims, 7 Drawing Sheets



12-11-'04 14:49 從- WINSTON HSU,NO.41526 8064986673

T-192 P01/17 U-330

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Voice Mail: 302-729-1562 FAX:806-498-6673 e-mail:winstonhsu@naipo.com

FAX TO : Pert, Evan T

ART UNIT: 2829

Tel : (571) 272-2800

Fax: (703) 872-9306

FROM : Winston Hsu, PATENT AGENT, REG. NO. : 41,526

SUBJECT: SERIAL NO. : 10/065,432

REQUEST FOR CONTINUED EXAMINATION (RCE)

TOTAL PAGES : 17 PAGES (INCLUDING COVER PAGE)

Winston Hsu 2004/11/12

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PTO/SB/30 (09-04)

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Request for Continued Examination (RCE) Transmittal

Address to:
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Commissioner for Patents
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Alexandria, VA 22313-1450

Application Number	10/085,432
Filing Date	10/17/2002
First Named Inventor	Ting-Kuo Kang
Art Unit	2829
Examiner Name	Peri, Evan T
Attorney Docket Number	NAUP0496USA

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application. Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. See Instruction Sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. **Submission required under 37 CFR 1.114** Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

- a. ☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.
- i. ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
- ii. ☐ Other _____
- b. ☒ Enclosed
- i. ☒ Amendment/Reply
- ii. ☐ Affidavit(s)/Declaration(s)
- iii. ☐ Information Disclosure Statement (IDS)
- iv. ☐ Other _____

2. Miscellaneous

- a. ☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of _____ months. (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(f) required)
- b. ☐ Other _____

3. Fees

The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.

The Director is hereby authorizing to charge the following fees, or credit any overpayments, to

- a. ☒ Deposit Account No. 503105. I have enclosed a duplicate copy of this sheet.

- i. ☒ RCE fee required under 37 CFR 1.17(e)
- ii. ☐ Extension of time fee (37 CFR 1.135 and 1.17)
- iii. ☐ Other _____

- b. ☐ Check in the amount of \$ _____ enclosed

- c. ☐ Payment by credit card (Form PTO-2038 enclosed)

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SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

Signature	<i>Winston Hsu</i>	Date	11/12/2004
Name (Print/Type)	Winston Hsu	Registration No.	41,526

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Name (Print/Type)			

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T-192 P03/17 U-330

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FEE TRANSMITTAL for FY 2005

Effective 10/01/2004. Patent fees are subject to annual revision.

<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27		Complete if Known	
TOTAL AMOUNT OF PAYMENT (\$ 780.00)		Application Number	10/065,432
		Filing Date	10/17/2002
		First Named Inventor	Ting-Kuo Kang
		Examiner Name	Pert, Evan T
		Art Unit	2828
		Attorney Docket No.	NAUP0496USA

METHOD OF PAYMENT (check all that apply)		FEE CALCULATION (continued)	
<input type="checkbox"/> Check <input type="checkbox"/> Credit card <input type="checkbox"/> Money Order <input type="checkbox"/> Other <input type="checkbox"/> None		3. ADDITIONAL FEES	
<input checked="" type="checkbox"/> Deposit Account: Deposit Account Number: 50-3105 Deposit Account Name: North America Intellectual Property Corp.		Large Entity Small Entity	
The Director is authorized to: (check all that apply) <input checked="" type="checkbox"/> Charge fee(s) indicated below <input checked="" type="checkbox"/> Credit any overpayments <input checked="" type="checkbox"/> Charge any additional fee(s) or any underpayment of fee(s) <input type="checkbox"/> Charge fee(s) indicated below, except for the filing fee to the above-identified deposit account.			
FEE CALCULATION			
1. BASIC FILING FEE			
Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description	Fee Paid
1001 790	2001 395	Utility filing fee	
1002 350	2002 175	Design filing fee	
1003 550	2003 275	Plant filing fee	
1004 790	2004 395	Reissue filing fee	
1005 180	2005 80	Provisional filing fee	
SUBTOTAL (1) (\$ 0.00)			
2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE			
Total Claims: 20** = <input type="text"/> X <input type="text"/> = <input type="text"/> Independent Claims: 3** = <input type="text"/> X <input type="text"/> = <input type="text"/> Multiple Dependent: <input type="text"/> = <input type="text"/>			
Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description	Fee Paid
1202 18	2202 9	Claims in excess of 20	
1201 88	2201 44	Independent claims in excess of 3	
1203 300	2203 150	Multiple dependent claim, if not paid	
1204 88	2204 44	** Reissue independent claims over original patent	
1205 18	2205 9	** Reissue claims in excess of 20 and over original patent	
SUBTOTAL (2) (\$ 0.00)			
**or number previously paid, if greater; For Reissues, see above			
		Other fee (specify)	
		SUBTOTAL (3) (\$ 780.00)	

SUBMITTED BY		(Complete if applicable)	
Name (Print/Type)	Winston Hsu	Registration No.	41,526
Signature	<i>Winston Hsu</i>	Telephone	302-729-1582
		Date	11/12/2004

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T-192 P04/17 U-330

PTO/SB/97 (09-04)

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Shelley Kuo

Signature

Shelley Kuo

Typed or printed name of person signing Certificate

Voice Mail: 302-729-1562

Registration Number, if applicable

Telephone Number

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APPLICATION NUMBER: 10/065,432

PAPERS INCLUDED:

(1) Transmittal Form

1 PAGE

(2) Fee Transmittal

1 PAGE

(3) Request for Continued Examination

13 PAGES

This collection of information is required by 37 CFR 1.8. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1.8 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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T-192 P05/17 U-330

METHOD FOR MONITORING OXIDE QUALITY

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Appl. No. : 10/065,432 Confirmation
No.6760

Applicant : Ting-Kuo Kang,
Yi-Fan Chen,
Chia-Jen Kao

Filed : October 17, 2002

TC/A.U. : 2829

Examiner : Pert, Evan T

Docket No. : NAUP0496USA

Customer : 027765

No.

Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

AMENDMENT

Sir:

- 5 In response to the notice of allowance mailed 08/30/2004, a request for continued examination is submitted and amendments to the above-identified application are as follows:

Amendments to the Specification begin on page 2 of this paper.

- 10 Amendments to the Claims are reflected in the listing of claims which begins on page 3 of this paper.

Remarks/Arguments begin on page 12 of this paper.

12-11-'04 14:51 從- WINSTON HSU,NO.41526 8064986673

T-192 P06/17 U-330

Appl. No. 10/065,432
Amdt. dated November 12, 2004
Request for Continued Examination

Amendments to the Specification:

Please replace the title "METHOD FOR MONITORING OXIDE QUALITY" with the following new title:

--METHOD OF MANUFACTURING A SEMICONDUCTOR DEVICE
5 HAVING AN OXIDE LAYER--

12-11-'04 14:51 從- WINSTON HSU,NO.41526 8064986673

T-192 P07/17 U-330

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Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

5 Claim 1 (currently amended): A method of manufacturing a semiconductor device having a tunnel oxide layer ~~for monitoring a tunnel oxide layer~~, the method comprising:

- (a) providing a semiconductor substrate and forming at least one memory cell on a surface of the semiconductor substrate, the memory
10 cell comprising a first gate, a second gate, and the tunnel oxide layer from top to bottom in a stack;
- (b) electrically connecting the first gate and the second gate;
- (c) applying a first gate voltage to the first gate, the first gate voltage being a swing time-dependent DC ramping voltage;
- 15 (d) measuring a first gate leakage current of the memory cell to calculate a first constant from an equation;
- (e) applying a second gate voltage to the first gate, the second gate voltage being a swing time-dependent DC ramping voltage;
- 20 (f) measuring a second gate leakage current of the memory cell to calculate a second constant from the equation;
- (g) calculating a first ratio of the second constant to the first constant; and
- (h) performing a comparing step to compare the value of the first ratio with a predetermined value.

25

Claim 2 (previously presented): The method of claim 1 wherein the semiconductor substrate is a silicon substrate of a semiconductor wafer and the memory cell is formed in a testing area of the semiconductor wafer.

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Claim 3 (original): The method of claim 1 wherein the memory cell is a flash memory cell, the first gate and the second gate are a controlling gate and a floating gate of the flash memory cell respectively.

5

Claim 4 (original): The method of claim 1 wherein the memory cell is a non-volatile memory cell, the first gate and the second gate are a controlling gate and a floating gate of the non-volatile memory cell respectively.

10

Claim 5 (original): The method of claim 1 wherein the quality of the tunnel oxide layer is degenerated to be not acceptable when the value of the first ratio is greater than the predetermined value.

15

Claim 6 (previously presented): The method of claim 1 wherein the equation is the Fowler-Nordheim tunneling mechanism equation.

Claim 7 (original): The method of claim 1 wherein the predetermined value is 10.

20

Claim 8 (original): The method of claim 1 wherein each constant is a . value corresponding to each gate voltage respectively.

Claim 9 (previously presented): The method of claim 8 wherein the first constant is a . 1 value corresponding to the first gate voltage and the . 1 value is equal to $\left[\frac{\Delta \ln \left(\frac{\text{the first gate leakage current}}{\left(\left| \text{the first gate voltage} \right| - \left| \text{a flatband voltage} (V_{fb}) \right| \right)^2} \right) + \Delta \left[1 + \left(\left| \text{the first gate voltage} \right| - \left| \text{the flatband voltage} \right| \right) \right] \right]$.

Claim 10 (currently amended): The method of claim 8 wherein the second constant is a . 2 value corresponding to the second gate voltage

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and the . 2 value is equal to $\left[\frac{\Delta \ln[| \text{the second gate leakage current} | / (| \text{the second gate voltage} | - | \text{the flatband voltage}(V_{fb}) |)^2]}{\Delta [1 \div (| \text{the second gate voltage} | - | \text{the flatband voltage} |)]} \right]$.

5 Claim 11 (currently amended): The method of claim 8 further comprising the following steps when the value of the first ratio is not greater than the predetermined value:

applying a third gate voltage to the first gate, the third gate voltage being a swing time-dependent DC ramping voltage;

10 measuring a third gate leakage current of the memory cell to calculate a third constant from the equation;

calculating a second ratio of the third constant to the second constant; and

performing the comparing step to compare the value of the second ratio with the predetermined value.

Claim 12 (original): The method of claim 11 wherein the steps (c) to (h) are repeated when the value of the second ratio is not greater than the predetermined value.

Claim 13 (original): The method of claim 11 wherein the quality of the tunnel oxide layer is degenerated to be not acceptable when the value of the second ratio is greater than the predetermined value.

25 Claim 14 (previously presented): The method of claim 11 wherein the third constant is a . 3 value corresponding to the third gate voltage and the . 3 value is equal to $\left[\frac{\Delta \ln[| \text{the third gate leakage current} | / (| \text{the third gate voltage} | - | \text{a flatband voltage}(V_{fb}) |)^2]}{\Delta [1 \div (| \text{the third gate voltage} | - | \text{the flatband voltage} |)]} \right]$.

Claim 15 (currently amended): The method of claim 14 further

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comprising ~~a step for~~ plotting a $-V_g$ curve of each I value respectively corresponding to the first gate voltage, the second gate voltage and the third gate voltage versus the first gate voltage, the second gate voltage and the third gate voltage, and comparing a reference $-V_g$ curve for the unstress-induced tunnel oxide layer in the memory cell ~~is compared~~ with the $-V_g$ curve to monitor the quality of the tunnel oxide layer.

Claim 16 (original): The method of claim 15 wherein the $-V_g$ curve comprises at least a first region (region I), a second region (region II), and a third region (region III).

Claim 17 (currently amended): The method of claim 16 wherein the I value within the first region is zero to represent each gate leakage current flowing through the first gate and the second gate in the memory cell being less than a predetermined current value, the absolute value of the I value within the second region increases to represent the stress-induced leakage current (SILC) resulting in the increase of each gate leakage current of the memory cell, and the I value within the third region crosses the reference $-V_g$ curve to represent a plurality of carriers being trapped by the tunnel oxide layer.

Claim 18 (original): The method of claim 17 wherein the predetermined current value is 1.0×10^{-11} A.

Claim 19 (currently amended): The method of claim 8, further comprising ~~a step for~~ plotting a $-V_g$ curve of each I value versus each gate voltage, and comparing a reference $-V_g$ curve for the unstress-induced tunnel oxide layer in the memory cell ~~is compared~~ with the $-V_g$ curve to monitor the quality of the tunnel oxide layer.

30

Claim 20 (original): The method of claim 1 wherein the method is applied to a wafer acceptance testing (WAT) equipment to fast monitor

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the stress-induced degradation of the tunnel oxide layer in the memory cell.

5 Claim 21 (currently amended) A method of manufacturing a semiconductor device having an oxide layer ~~for fast monitoring the stress-induced degradation of an oxide layer by a wafer acceptance testing (WAT) equipment~~, the method comprising:

(a) providing a substrate, a surface of the substrate comprising the oxide layer and a first conductive layer disposed on the oxide layer;

10 (b) applying a first voltage to the first conductive layer, the first voltage being a swing time-dependent DC ramping voltage;

(c) measuring a first leakage current flowing through the first conductive layer to calculate a first proportional value from the first voltage, the first leakage current, and an equation, the first
15 proportional value corresponding to the first voltage;

(d) applying a second voltage to the first conductive layer, the second voltage being a swing time-dependent DC ramping voltage;

(e) measuring a second leakage current flowing through the first conductive layer to calculate a second proportional value from the
20 second voltage, the second leakage current, and the equation, the second proportional value corresponding to the second voltage; and

(f) calculating a first ratio of the second proportional value to the first proportional value.

25 Claim 22 (previously presented): The method of claim 21 wherein the substrate is a silicon substrate of a semiconductor wafer and the first conductive layer is formed in a testing area of the semiconductor wafer.

Claim 23 (previously presented): The method of claim 21 wherein a
30 second conductive layer is formed between the first conductive layer and the oxide layer.

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Claim 24 (previously presented): The method of claim 23 further comprising an electrically connecting step performed before applying the first voltage to the first conductive layer to electrically connect the first conductive layer and the second conductive layer.

5

Claim 25 (previously presented): The method of claim 24 wherein the first conductive layer and the second conductive layer are a controlling gate and a floating gate of a flash memory cell respectively, and the oxide layer is a tunnel oxide layer of the flash memory cell.

10

Claim 26 (currently amended): The method of claim 24 wherein the first conductive layer is a controlling gate of a non-volatile memory cell, the second conductive layer is a floating gate of the non-volatile memory cell, and the oxide layer is a tunnel oxide layer of the non-volatile memory cell.

15

Claim 27 (previously presented): The method of claim 21 wherein the first conductive layer is a gate of a metal-oxide-semiconductor (MOS) transistor, the oxide layer is a gate oxide layer of the MOS transistor.

20

Claim 28 (previously presented): The method of claim 21 further comprising a comparing step to compare the value of the first ratio with a predetermined value.

25

Claim 29 (previously presented): The method of claim 28 wherein the quality of the oxide layer is degenerated to be not acceptable when the value of the first ratio is greater than the predetermined value.

30

Claim 30 (original): The method of claim 28 wherein the predetermined value is 10.

Claim 31 (previously presented): The method of claim 21 wherein the

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equation is the Fowler-Nordheim tunneling mechanism equation.

Claim 32 (previously presented): The method of claim 28 wherein each proportional value is a . value corresponding to each voltage
 5 respectively.

Claim 33 (previously presented): The method of claim 32 wherein the first proportional value is a . 1 value corresponding to the first voltage and the . 1 value is equal to $\left[\frac{\Delta \ln \left(\frac{\text{the first leakage current}}{\left(\left| \text{the first voltage} \right| - \left| \text{a flatband voltage}(V_{fb}) \right| \right)^2} \right)}{\Delta \left[1 + \left(\left| \text{the first voltage} \right| - \left| \text{the flatband voltage} \right| \right) \right]} \right]$.
 10

Claim 34 (currently amended): The method of claim 32 wherein the second proportional value is a . 2 value corresponding to the second voltage and the . 2 value is equal to $\left[\frac{\Delta \ln \left(\frac{\text{the second leakage current}}{\left(\left| \text{the second voltage} \right| - \left| \text{the flatband voltage}(V_{fb}) \right| \right)^2} \right)}{\Delta \left[1 + \left(\left| \text{the second voltage} \right| - \left| \text{the flatband voltage} \right| \right) \right]} \right]$.
 15

Claim 35 (currently amended): The method of claim 32 further comprising the following steps when the value of the first ratio is not greater than the predetermined value:
 20

applying a third voltage to the first conductive layer, the third voltage being a swing time-dependent DC ramping voltage;

measuring a third leakage current flowing through the first
 25 conductive layer;

calculating a third proportional value from the third voltage, the third leakage current, and the equation, the third proportional value corresponding to the third voltage;

calculating a second ratio of the third proportional value to the
 30 second proportional value; and

performing the comparing step to compare the value of the second

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 ratio with the predetermined value.

Claim 36 (original): The method of claim 35 wherein the steps (b) to (f)
 are repeated when the value of the second ratio is not greater than the
 5 predetermined value.

Claim 37 (original): The method of claim 35 wherein the quality of the
 oxide layer is degenerated to be not acceptable when the value of the
 second ratio is greater than the predetermined value.

10

Claim 38 (previously presented): The method of claim 35 wherein the
 third proportional value is a .3 value corresponding to the third voltage
 and the .3 value is equal to $\left[\frac{\Delta \ln[| \text{the third leakage current} | / (| \text{the third voltage} | - | \text{a flatband voltage} (V_{fb}) |)^2]}{\Delta [1 + (| \text{the third voltage} | - | \text{the flatband voltage} |)]} \right]$.
 15

Claim 39 (currently amended): The method of claim 38 further
 comprising ~~a step for plotting a .-V curve of each . value respectively~~
 corresponding to the first voltage, the second voltage and the third
 20 voltage versus the first voltage, the second voltage and the third
 voltage, and comparing a reference .-V curve for the unstress-induced
 oxide layer ~~is compared with the .-V curve to monitor the quality of~~
 the oxide layer.

25 Claim 40 (previously presented): The method of claim 39 wherein the
 .-V curve comprises at least a first region (region I), a second region
 (region II), and a third region (region III).

Claim 41 (currently amended): The method of claim 40 wherein the
 30 value within the first region is zero to represent each leakage current
 flowing through the first conductive layer being less than a
 predetermined current value, the absolute value of the . value within

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the second region increases to represent the stress-induced leakage current (SILC) resulting in the increase of each leakage current flowing through the first conductive layer, and the . value within the third region crosses the reference .-V curve to represent a plurality of
5 carriers being trapped by the oxide layer.

Claim 42 (original): The method of claim 41 wherein the predetermined current value is 1.0×10^{-11} A.

10 Claim 43 (currently amended): The method of claim 32 further comprising ~~a step for plotting~~ a .-V curve of each . value versus each voltage, and comparing a reference .-V curve for the unstress-induced oxide layer ~~is compared~~ with the .-V curve to monitor the quality of the oxide layer.

15

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REMARKS/ARGUMENTS

1. Request for continued examination:

5

The Applicant respectfully requests continued examination of the above-indicated application as per 37 CFR §1.114.

2. Amendments to the specification:

10

The title of the present application is amended to correspond with the amendments to the claims so as to be clearly indicative of the invention to which the claims are directed. No new matter is introduced by the amendments in the specification. Allowance of the amended specification is respectfully requested.

3. Amendments to the claims:

In claims 1 and 21, the preambles thereof are amended to emphasize the outstanding feature of the present invention is to introduce the steps for monitoring the quality of an oxide layer into the method of manufacturing a semiconductor device having the oxide layer. These amendments are entirely supported by the disclosure. For example, paragraph [0004] recites that the semiconductor devices include MOS transistors, non-volatile memory and flash memory. Paragraph [0021] recites that the present invention examines the oxide layer quality with an in-line monitor. Paragraph [0033] recites the steps for forming the semiconductor devices in both a testing area and a normal product area. In addition, paragraphs [0034] and [0048] further recite that the steps of providing swing time-dependent DC ramping voltages and measuring leakage currents are performed in a production line. It is obvious that the steps for monitoring the oxide layer quality

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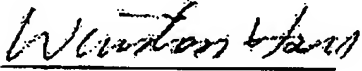
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can be introduced into the method of manufacturing the semiconductor devices according to the present application. Consideration of the amended claims 1 and 21 is respectfully requested.

5 Claims 10, 11, 15, 17, 19, 26, 34, 35, 39, 41, and 43 are amended to correct minor grammatical informalities identified in the claims. No new matter is introduced. Allowance of the amended claims is respectfully requested.

10 As claims 2-20 and 22-43 are dependent upon the amended claims 1 and 21, they should be allowed if the amended claims 1 and 21 are allowed. Consideration of claims 2-20 and 22-43 is therefore requested.

15 Respectfully submitted,

Date: 2004/11/12

20 Winston Hsu, Patent Agent No. 41,526

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PERT, EVAN T

ART UNIT

PAPER NUMBER

2829

DATE MAILED: 12/20/2004

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/065,432	10/17/2002	Ting-Kuo Kang	NAUP0496USA	6760

TITLE OF INVENTION: METHOD OF MANUFACTURING A SEMICONDUCTOR DEVICE HAVING AN OXIDE LAYER

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	\$1400	\$300	\$1700	03/21/2005

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE REFLECTS A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE APPLIED IN THIS APPLICATION. THE PTOL-85B (OR AN EQUIVALENT) MUST BE RETURNED WITHIN THIS PERIOD EVEN IF NO FEE IS DUE OR THE APPLICATION WILL BE REGARDED AS ABANDONED.

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If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

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II. PART B - FEE(S) TRANSMITTAL should be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). Even if the fee(s) have already been paid, Part B - Fee(s) Transmittal should be completed and returned. If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted.

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(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/065,432	10/17/2002	Ting-Kuo Kang	NAUP0496USA	6760

TITLE OF INVENTION: METHOD OF MANUFACTURING A SEMICONDUCTOR DEVICE HAVING AN OXIDE LAYER

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	\$1400	\$300	\$1700	03/21/2005

EXAMINER	ART UNIT	CLASS-SUBCLASS
PERT, EVAN T.	2829	438-018000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47, Rev 03-02 or more recent) attached. Use of a Customer Number is required.

2. For printing on the patent front page, list

- (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, 1 _____
- (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. 2 _____
- 3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are enclosed:

- ☐ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies _____

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- ☐ A check in the amount of the fee(s) is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☐ The Director is hereby authorized by charge the required fee(s), or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. Change In Entity Status (from status indicated above)

- ☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27. ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

The Director of the USPTO is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above.

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant, a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

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This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/065,432	10/17/2002	Ting-Kuo Kang	NAUP0496USA	6760
027765	7590	12/20/2004		
(NAIPC) NORTH AMERICA INTERNATIONAL PATENT OFFICE P.O. BOX 506 MERRIFIELD, VA 22116			EXAMINER PERT, EVANT	
			ART UNIT	PAPER NUMBER
			2829	

DATE MAILED: 12/20/2004

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 135 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 135 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (703) 305-1383. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at (703) 305-8283.